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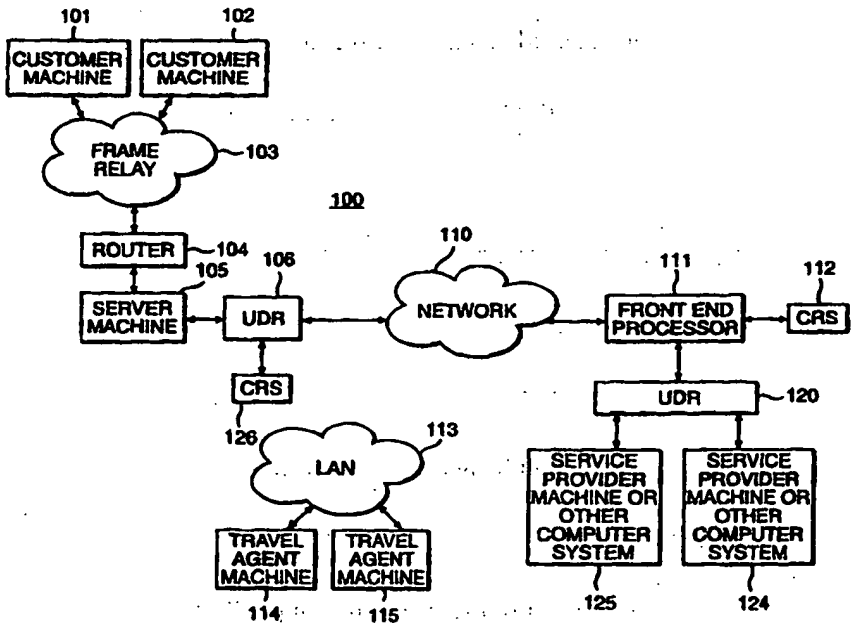

(57) Abstract

Conversion of a data in a variable field message to a fixed format message. The variable field message has a varying length and fields of varying types of data. The corresponding fixed format message has fields of a fixed data type and length, which facilitates parsing and processing data from the variable field message. Customers for the data conversion or other processing are load balanced among multiple servers sharing load level information.

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APPARATUS AND METHOD FOR DATA CONVERSION AND LOAD BALANCING IN A COMPUTER NETWORK

FIELD OF THE INVENTION

The present invention relates to an apparatus and method for performing conversion of data and for load balancing between machines in a computer network.

BACKGROUND OF THE INVENTION

A computerized reservation system (CRS) traditionally has provided a communications network for travel agents or other persons to book airline reservations. Other companies may interface their computer systems with a CRS in order to make information concerning their services available via the CRS. For example, a hotel company may interface its reservation system with a CRS so that when a person books an airline reservation, he or she may also make a hotel reservation through the same network.

CRS's typically use a complex protocol for identifying and transferring data. Other companies desiring to interface their computer systems with a CRS, therefore, may find it difficult or expensive to modify their computer systems to accommodate the complex protocol of a CRS. This situation may discourage other companies from interfacing their computer systems with a CRS, which limits the available information via that network.

In addition, customers interfacing their computer systems with a CRS are typically routed through servers (or other machines) interfacing with the CRS. Generally, different servers are assigned to particular customers and service only those customers, each customer being typically routed through only one server. Therefore, if that server becomes nonfunctional, service to the customer is unavailable until the server can be brought back into operation or back on-line.

Accordingly, a need exists for data conversion and for load balancing access to a CRS or other computer network.

SUMMARY OF THE INVENTION

An apparatus consistent with the present invention converts message formats. The apparatus receives an input message in a variable field format and identifies data types for each field of the input message. The apparatus assembles an output message

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having multiple fields defined by a fixed format, and it maps data from the input message to specified fields in the output message based on the identified data types.

A method consistent with the present invention provides for computer-implemented message format conversion. The method receives an input message in a variable field format and identifies data types for each field of the input message. The method assembles an output message having multiple fields defined by a fixed format, and it maps data from the input message to specified fields in the output message based on the identified data types.

Another apparatus consistent with the present invention provides for load balancing of processing provided by multiple server machines interfaced with a client machine servicing multiple customers. The apparatus assigns each of the customers to a set of the server machines and stores load levels of each of the server machines. The apparatus services the customers using the server machines to which they are assigned based upon the load levels. If the server machines to which they are assigned are unavailable, the apparatus services the customers using the server machines to which they are temporarily assigned during the unavailability.

Another method consistent with the present invention load balances processing provided by multiple server machines interfaced with a client machine servicing multiple customers. The method assigns each of the customers to a set of the server machines and stores load levels of each of the server machines. The method services the customers using the server machines to which they are assigned based upon the load levels. If the server machines to which they are assigned are unavailable, the method services the customers using the server machines to which they are temporarily assigned during the unavailability.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are incorporated in and constitute a part of this specification and, together with the description, explain the advantages and principles of the invention. In the drawings,

FIG. 1 is a diagram of an exemplary computer network in which systems consistent with the present invention may be implemented including multiple CRS's;

FIG. 2 is a diagram of an exemplary apparatus for performing data conversion;

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FIG. 3 is a data structure diagram representing an example of a correlation between a variable field protocol and a fixed field protocol;

FIG. 4 is a flow chart of a process for performing data conversion from a variable field protocol to a fixed field protocol;

FIG. 5 is a diagram of an exemplary apparatus for performing load balancing;

FIG. 6 is a flow chart of a process for a client machine to interface with server machines performing load balancing; and

FIG. 7 is a flow chart of a process for server machines performing load balancing to interface with a client machine.

DETAILED DESCRIPTION

The following detailed description of the invention refers to the accompanying drawings. While the description includes exemplary embodiments, other embodiments are possible, and changes may be made to the embodiments described without departing from the spirit and scope of the invention. The following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims and their equivalents.

FIG. 1 is a diagram of an exemplary network 100 including multiple CRS's. CRS's are networks permitting access to, for example, travel-related information for making reservations or obtaining such information, and CRS's may use and provide other types of information, depending upon the computer systems interfaced with a particular CRS or the information accessible by the CRS. CRS's are also referred to as computer reservation systems or central reservation systems. In European countries, for example, CRS's are often referred to as global distribution systems. The term "computerized reservation system" and the abbreviation "CRS" are intended to encompass computerized reservation systems, computer reservation systems, central reservation systems, and global distribution systems. Examples of CRS's include those known by the following trademarks and companies: SABRE; AMADEUS; WORLDSPAN; SYSTEM ONE; APOLLO; GEMINI; GALILEO; and AXESS.

Network 100 illustrates how customers or service providers may be linked together through a CRS 112 or 126. For example, customer machines 101 and 102 may represent machines located at particular corporations or other entities for providing

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travel-related and other services for that corporation or entity. Customer machines 101 and 102 are typically interfaced through a frame relay 103 and a router 104 to a server machine 105. Router 104 provides for routing of a protocol over frame relay 104 for long distance communication. Frame relays and routers are known in the art. Server machine 105 provides necessary interaction between the ultimate customer machines and a CRS, for example, CRS 126.

Server machine 105 is typically interfaced through a universal data router (UDR) 106 to a network 110. UDR 106 may include several servers, as explained below, for performing data conversion for server 105 to communicate with a CRS, for example, CRS 126. Network 110 may represent a private network such as the Societe Internationale Telecommunications Aeronautiques (SITA) network. Network 110 interfaces UDR 106 with a front end processor 111, which provides an interface to a CRS 112. CRS's usually include a front end processor, which are known mainframe components, providing functionality for interfacing the CRS with a network. Customer machines 101 and 102 may also be interfaced with other CRS's 126 through UDR 106. Therefore, when a person at customer machine 101 or 102 desires to, for example, book a travel-related reservation or access other types of information, a communications link is established through the various elements between the customer machine and CRS 112 or 126.

In addition, network 110 may interface travel agent machines with CRS 112 or 126. In particular, network 110 may interface a local area network (LAN) 113 connected to travel agent machines 114 and 115. Travel agent machines 114 and 115, if located overseas, may also be linked into CRS 112 or 126, in which case network 110 may interface token ring LAN 113 through an international telephone or computer network (not shown). Travel agent machines and LANs are known in the art.

Other companies or service providers may also provide information available via CRS 112. They provide such information by interfacing service provider machines (or other computer systems) 124 and 125 through UDR 120 to front end processor 111. UDR 120, which may include several servers as explained below, provides data conversion to interface the computer systems of service provider machines 124 and 125 with the protocol used by CRS 112. Alternatively, service provide machines 124 and

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125 may interface with UDR 106 or CRS 126.

Data Conversion

Data conversion is useful, for example, for converting messages in a variable field format into a fixed format, making it easier for service providers to communicate electronically with a CRS that employs the Edifact protocol, explained below, based on a variable field message format. CRS's typically operate using the Edifact protocol, which is complex. A challenge for companies operating CRS's who want to add other computer systems to the CRS involves making it cost-effective for the other computer systems to interface with data in the Edifact protocol. A data conversion explained below, for converting from the Edifact protocol to a fixed format message provides an advantage of reducing expense and time for a service provider or other company to interface its computer system with a CRS in comparison to directly with data in the Edifact protocol. An embodiment, consistent with the present invention, converts data in the Edifact protocol to a fixed format message. The availability of information in a fixed format message, rather than having to interface directly with data in the Edifact protocol, significantly reduces the complexity of interfacing computer systems with the CRS. Interfacing other computer systems with a CRS increases the information available through the CRS and hence may increase the usefulness of the network including the CRS and the systems interfacing it.

FIG. 2 is a diagram of a data converter 201 for performing conversion of data. This conversion may be performed, for example, in UDR 120 between CRS 112 and service provider machines 124 and 125 shown in FIG. 1. As shown in FIG. 2, the conversion generally occurs between a client machine 207 and server machine 204. Client machine 207 interfaces with a plurality of terminals 208, 209, and 210. Client machine 207 may represent, for example, a computer system of a service provider, for example, service provider machine 125, providing travel-related services or access to other information, and terminals 208, 209, and 210 may represent computer terminals for users to interact with the computer system, for example, client machine. Server machine 204 interfaces with a CRS 205 and possibly another network 206. Alternatively, data converter 201 may interface directly with a CRS as shown by the dashed line. Data converter 201 includes a conversion engine 203 interfacing a function library 202 for

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retrieving particular software functions or scripts for performing data conversion depending on the segments or fields within a received message.

As identified above, CRS's, such as CRS 205, typically use a known protocol referred to as the Edifact (electronic data interchange for administration, commerce and transport) protocol or standard. Various versions of the Edifact protocol exist, such as those known as IOTA and UN standards, and the Edifact protocol is used generally for processing data for travel, banking, and industrial purposes. An example of the Edifact protocol is explained in the following document, which is incorporated herein by reference: Henry Schlieper, "Henry's Yellow UN/EDIFACT Book; Introduction to UN/EDIFACT Messages," 10th revised issue (October 1996). The term "Edifact" in this description is intended to cover any version of the Edifact protocol used for any purpose. With reference to FIG. 2, server machine 204 processes, for example, data formatted according to the Edifact protocol, which is complex. Client machine 207, on the other hand, may use its own protocol for the data on which it operates, particularly if client machine 207 represents the computer system of a service provider that does not support the CRS protocol. Data converter 201 provides a fixed format message to client machine 207. Thus, data converter 201 thus may provide a more simple interface for client machine 207 such that client machine 207 need not analyze a message in the complex Edifact or other protocol.

The Edifact protocol is in some respects complex because it includes variable fields. In other words, a particular type of data may appear in different fields depending upon each particular Edifact message, which is data formatted according to the Edifact protocol. There are different types of Edifact messages and examples include, but are not limited to, the following: Availability Request Message (AVLREQ), Availability Response Message (AVLRSP), Profile Request message (PROREQ), Profile Response Message (PRORSP), Reservation Request Message (RESREQ) and Reservation Response Message (RESRSP).

In general, a variable field message includes data formatted according to a variable field protocol. Edifact or other variable field messages may not be of fixed length and, depending on the data to be transmitted, the length of Edifact or other variable field messages may change. Thus, a machine receiving an Edifact or other

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variable field message cannot necessarily determine that certain data is of a particular type because of the field in which it exists. In order to understand an Edifact or other variable field message, a machine typically has to analyze each segment of data in the message to determine the type of data.

A fixed format message is a record or other data structure in which each particular field is known or predefined so that in a stream of data, for example, each field has a certain length and type of content. With data in a fixed format message, therefore, a machine need only, for example, count bytes to determine fields and data types. Thus, in a fixed format message, the data for each segment is typically at a particular position or offset in the message, which facilities a customer's ease in processing the data and may result in a faster rate of data manipulation than if the customer were to analyze an Edifact or other variable field message.

A fixed format message data structure may be of fixed length for each type of Edifact or other variable field message. A structure for a fixed format message is typically defined depending on a particular Edifact or other variable field message and data required by a customer or a particular application. For each Edifact or other variable field message data structures, one or more fixed format messages may be defined. A fixed format message may be defined by analyzing the Edifact or other variable field message data structure for each type of message and may depend upon the size and characteristics of the messages. The description of data fields for the structure of a fixed format message may change depending on the type of data received or transmitted. It is possible to define one fixed format message for all Edifact messages. However, that fixed format message would be large, containing fields that may not be used by many Edifact messages and potentially adversely affecting processing speed because of its size. Therefore, it may be more advantageous to defined a fixed format message for a group of Edifact messages, for example, ten to fifteen Edifact messages for one fixed format message.

FIG. 3 is an example of a data structure 300 illustrating a correlation between segments of an Edifact or other variable field message and corresponding fields of a fixed format message. The letters within each box represent a known segment of an Edifact message, and each box has a predefined length in bytes. The linking of the boxes

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illustrates how the fields are linked together and a definition of each one. The number nine in the box for the group 1 (GR1) segment means that the corresponding group of three segments (ODI, TVL, CNX) are repeated nine times. The number four in the box for the group 2 (GR2) segment means that the corresponding segment (TVL) is repeated four times. This example thus illustrates how variable fields of an Edifact or other variable field message may be translated into a fixed format message so that a system reading such a message knows the type of data in each field and its length. Table 1 provides an explanation of each thee-letter Edifact code in the data structure of FIG. 3.

TABLE 1

code	meaning
UNB	interchange header
UNH	message header
MSG	message segment
ORG	origination of request details
EQN	number of units
RPI	related product information
CRI	consumer reference information
SSR	special requirements details
ODI	origination and destination details
TVL	travel product information
CNX	connection details
UNT	message trailer
UNZ	interchange trailer

FIG. 4 is a flow chart of a process 400 for performing conversion between an Edifact or other variable field message and a fixed format message. Conversion engine 203 (FIG. 2) includes a processor for implementing the conversion process and retrieving software functions, referred to as scripts, from function library 202 for performing data conversion. For example, to convert each type of fixed format message one or more scripts may be used to perform the data conversion. An advantage of using scripts, or

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similar software processing, is that they may be modified and reloaded without a modification to the corresponding machine code. Conversion engine 203 may compile scripts at run time and, depending on the data received, it may select the corresponding script or other software function and assemble a fixed format message from data in a variable field message.

As shown in FIG. 4, conversion engine 203 first receives an Edifact or other variable field message, typically including protocol information, from a CRS or other computer system (step 401). It may determine a type of the message based on predefined criteria such as, for example, requirements for the Edifact protocol. Conversion engine 203 reads a segment or field in the message (step 402), and it determines or identifies the type of data in that segment or field (step 403). The determination or identification may involve using the type of message, and it may also involve downloading predefined software functions from function library 202 to analyze particular message segments or fields. Conversion engine 203 determines the location of that type of data in the corresponding fixed format message (step 404), which is typically predefined so that it knows the structure and format of that type of message. Conversion engine 203 may also remove unnecessary protocol information from the data (step 405). The protocol information is generally not required in the fixed format message, as the size and data type of the fields may be predefined or known. Conversion engine 203 assembles the fixed format message and maps data from the Edifact or other variable field message to the fields in the fixed format message (step 406) by positioning the data, typically without the protocol information, in the corresponding fields for that data in the fixed format message.

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Conversion engine 203 determines if the Edifact or other variable field message contains more segments or fields to process (step 407). If so, it may repeat steps 402-406 to process those segments or fields. Once the message has been translated and the fixed format message has been assembled, conversion engine 203 sends the assembled fixed format message to a client machine or other computer system or network (step 408), and the system may send it in serialized form.

The following is example of a correlation between an Edifact message and a fixed format message. This example is provided for illustrative purposes only. Any type of fixed format message may be defined for an Edifact or other variable field message. An example of an Edifact message availability request is shown in Table 2.

TABLE 2

```
        UNB+UN:1
AALARES:IEDI+XXXX:IEDI+920130:1330+SES0001++AVRL1+E'
        UNH+1+AVLREQ:95:1:IA+57482()'
        MGS+1:29'
        ORG+AA:HDQ+31599253:A0B0+++1+US'EQN+4:9*2:10'
        CRI+6:8*6:10'
        ODI+DFW*MBJ'
        TVL+24121995:1115+DFW*MBJ+DL++++BCO'
        CNX+MIA'
        ODI+MBJ*DFW'
        TVL+12011995:1300+MBJ*DFW+DL++++BCO'
        CNX+MIA'
        UNT+12+1'
        UNZ+1+SES---1---1'
```

The Edifact message shown in Table 2 contains twelve segments such as, for example, UNB and UNH. Each segment may have multiple composites, each composite separated by a "+" symbol. Each element inside a composite may be separated by a ":" symbol. If a segment contains repeating elements, they may be separated by a "*"

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symbol. The data inside an Edifact or other variable field message may vary depending on the type of message and the required information.

The data in Table 3 shows an example of a correspondence between a fixed format message and the first three segments (UNH, UNB, MSG) of the Edifact message shown in Table 2. Table 3 provides the data field definitions in the first column along with the offset and the size of the data. The other segments may be defined in a similar manner. All data fields may be null terminated to obtain the defined length. For example, the first element in this data structure has a data field size of "5." The data is "UN" and the rest of the field includes three null characters (for example, "0") to obtain a five character field. Other characters may be used to terminate fields. Accordingly, the following is a serialized version of the first five fields of fixed format message shown in Table 3: "UN00010AALARES0000IEDI0XXXX0000000". The remaining fields may be attached in a similar manner by using null termination to obtain the appropriate field lengths.

TABLE 3

Edifact segment	fixed format field length		data
AVRQ-UNB.CTRLAGNCYCODE	Size:	5	'UN'
AVRQ-UNB.SYNTAXVERNO	Size:	2	'1'
AVRQ-UNB.INTAPPTITLE	Size:	11	'AALARES'
AVRQ-UNB.INTADDRVERSION	Size:	5	'IEDI'
AVRQ-UNB.APPENTITYTITLE	Size:	11	'XXXX'
AVRQ-UNB.ADDRVERSION	Size:	5	'IEDI'
AVRQ-UNB.DATEGMT	Size:	7	'920130'
AVRQ-UNB.TIMEGMT	Size:	5	'1330'
AVRQ-UNB.INTCTLREF	Size:	15	'SES00010001'
AVRQ-UNB.APPASSCID	Size:	15	'SES00010001'
AVRQ-UNB.FSEID	Size:	15	'AVLR1'

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AVRQ-UNB.ASSOCCODE	Size:	2	'E'
AVRQ-UNH.MSGREFNO	Size:	14	'1'
AVRQ-UNH.MSGTYPE	Size:	7	'AVLREQ'
AVRQ-UNH.MSGVERNO	Size:	3	'95'
AVRQ-UNH.MSGRLSNO	Size:	2	'1'
AVRQ-UNH.CNTLAGENCY	Size:	3	'IA'
AVRQ-UNH.COMACESREF	Size:	18	'574820'
AVRQ-MSG.BUSFUNCCODE	Size:	4	'1'
AVRQ-MSG.MESSFUNCCODE	Size:	4	'29'
AVRQ-MSG.RESPCODECNT	Size:	4	'0'
AVRQ-MSG-RESPCODE.RESPTYPE	Size:	3	'0'
AVRQ-MSG-RESPCODE.RESPTYPE	Size:	3	'0'
AVRQ-MSG-RESPCODE.RESPTYPE	Size:	3	'0'
AVRQ-MSG-RESPCODE.RESPTYPE	Size:	3	'0'
AVRQ-MSG-RESPCODE.RESPTYPE	Size:	3	'0'

Clustering Servers for Load Balancing

Load balancing involves assigning customers to one or more servers for performing processing for the customers. Balancing the customer load among the servers is important, for example, to maintain service to the customers and avoid downtime in which service is unavailable.

FIG. 5 is a block diagram illustrating how load balancing may be accomplished in a CRS or computer network. Machine or network 506 interfaces with client machine 501 through, in this example, four servers. These servers include server 502 servicing customer A, server 503 servicing customers A and B, server 504 servicing customers B and C, and server 505 servicing customers C and D. Each customer is thus assigned to one or more servers interfacing client machine 501 with machine or network 506. In addition, each server is typically assigned to a particular port and constitutes the address of that server, as shown by the exemplary port numbers. For example, server 502 is

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assigned to port 1000 (p1000), and the other servers are assigned in this example to sequential port numbers. Each server typically includes an element, such as a software table or other data structure, for storing load levels for each of the servers, explained below. As shown in FIG. 5, servers 502, 503, 504, and 505 contain, respectively, load level tables 507, 508, 509, and 510. Each server may have a table or other data structure indicating its own load level and the load levels of all other servers. Load levels may indicate, for example, how many customers a particular server machine is currently servicing. Using the load level information provides for additional load level balancing of customer processing by, for example, routing customers through the server with the lowest load level.

Therefore, load balancing may in general be accomplished using the assignment of customers to servers machines and the load level information. In particular, as mentioned above, customers may be assigned for service to a set of the servers, and each server may store load levels of each of the servers. Customers may be serviced using the servers to which they are assigned based upon the load levels. In particular, among the servers to which they assigned, they may be services by the server with the lowest load level. If the servers to which they are assigned are unavailable, the customers may be serviced using the servers to which they are temporarily assigned during the unavailability.

Servers 502-505 may represent, for example, the UDRs explained above. With reference to FIG. 1, client machine 501 may represent server machine 105 or service provider machines 124 and 125, and customers may represent customer machines 101 and 102, or service provider machines 124 and 125. Machine or network 506 may

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represent network 110, front end processor 111 in combination with CRS 112, or CRS 126. Thus, servers 502-505 may provide, for example, data conversion necessary for customer machines 101 and 102, or service provider machines 124 and 125, to interface with CRS's 126 and 112. The load balancing achieved by servers operating consistent with the present invention may be used in any applicable computer network and for any applicable processing.

FIG. 6 is a flow chart of a process 600 for client machine 501 to interface with servers 502-504 performing load balancing. Client machine 501 contains a processor and memory for performing the load balancing function. As shown in FIG. 6, the client machine sends a "request server" message, indicating that one of the customer machines needs service by one of the servers to which the customer is assigned (step 601). The client machine may broadcast the message to the ports of servers to which the customer is assigned. The client machine determines if it received a response (step 602). If it received a response, it connects to the server specified in the response (step 603). Otherwise, if it received no response, the client machine sends a "request any server message" (step 604). The client machine broadcasts this message to the ports for all servers.

FIG. 7 is a flow chart of a process 700 for servers 502-504 to interface with client machine 501. Each of the servers contains a processor and memory for performing this process. As shown in FIG. 7, each server is in a wait state waiting for a "server request" message from a client machine through an assigned port (step 701). When the server receives a message, it determines if the message is a "request server" message, meaning that a customer assigned to that particular server requested service (step 702). If so, the

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server determines if it is the least loaded server, which may be accomplished by evaluating its table of server load levels (step 704). The load levels may be stored in tables 507-510 for respective servers 502-505 (see FIG. 5). Load levels may constitute, for example, numerical values indicating how many customers a server is currently servicing.

If the server that received the "server request message, is the least loaded server, it sends a response to the client machine and sends to the other servers its new load level (step 706). The response indicates to the client machine that this particular server is available for servicing the customer requesting service. If the server is not the least loaded server, then it waits for another "server request" message (step 701).

If the received message was not a "request server" message, the server determines if the message is a "request any server" message (step 703). If so, the server clears its table containing the other servers load levels (step 705), and it sends a response to the client machine and sends to the other servers its new load level (step 706).

If the received message is neither of those messages, the server determines if the message is an "update other servers load level" message (step 707). If so, the server updates its table with the other servers new load levels (step 708) and waits for another message (step 708).

Additional servers may join the servers already servicing a group of customers. When a server joins the others, it may be predefined to service a group of customers and may broadcast a message to the other servers identifying itself and its load level. It then may perform the processing described above with respect to FIG. 7.

While the present invention has been described in connection with a preferred

BNSDOCID: <WO___9944155A2_I_>

embodiment, many modifications will be readily apparent to those skilled in the art, and this application is intended to cover any adaptations or variations thereof. For example, various other components for the elements shown in FIG. 1, different types of variable field messages and fixed format messages for data conversion, and more or fewer servers for load balancing may be used without departing from the scope of the invention. This invention should be limited only by the claims and equivalents thereof.

BNSDOCID: <WO___9944155A2_I_>

WHAT IS CLAIMED IS:

1. An apparatus for converting message formats, comprising:

means for receiving an input message in a variable field format;

means for identifying data types for each field of the input message;

means for assembling an output message having multiple fields defined by a fixed format; and

means for mapping data from the input message to specified fields in the output message based on the identified data types.

2. The apparatus of claim 1 wherein

the receiving means includes means for determining a type of the input message based on predefined criteria, and

the identifying means includes means for using the input message type to identify the data types.

3. The apparatus of claim 1 wherein

the receiving means includes means for receiving protocol information with the data, and

the assembling means includes means for removing protocol information from the data.

4. The apparatus of claim 1 wherein the identifying means includes

means for downloading predefined functions for determining the type of the data.

BNSDOCID: <WO___9944155A2_I_>

5. The apparatus of claim 1 wherein the receiving means includes means for receiving the variable field message formatted according to Edifact protocol.

6. The apparatus of claim 1 wherein the receiving means includes means for receiving the variable field message from a computerized reservation system.

7. The apparatus of claim 1 wherein the assembling means includes means for generating a serialized version of the fixed format message.

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8. A system for converting a variable field message into a fixed format message, comprising:

a server machine;

a client machine; and

an apparatus, interfacing the client machine with the server machine, for converting message formats, the apparatus including:

means for receiving an input message in a variable field format;

means for identifying data types for each field of the input message;

means for assembling an output message having multiple fields defined by a fixed format; and

means for mapping data from the input message to specified fields in the output message based on the identified data types.

9. The system of claim 8 wherein

the receiving means includes means for determining a type of the input message based on predefined criteria, and

the identifying means includes means for using the input message type to identify the data types.

10. The system of claim 8 wherein

the receiving means includes means for receiving protocol information with the data, and

the assembling means includes means for removing protocol information from

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the data.

11. The system of claim 8 wherein the identifying means includes means for downloading predefined functions for determining the type of the data.

12. The system of claim 8 wherein the receiving means includes means for receiving the variable field message formatted according to Edifact protocol.

13. The system of claim 8 wherein the receiving means includes means for receiving the variable field message from a computerized reservation system.

14. The system of claim 8 wherein the assembling means includes means for generating a serialized version of the fixed format message.

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15. A computer-implemented message format conversion method, comprising the steps of:

receiving an input message in a variable field format;

identifying data types for each field of the input message;

assembling an output message having multiple fields defined by a fixed format; and

mapping data from the input message to specified fields in the output message based on the identified data types.

16. The method of claim 15 wherein

the receiving step includes the step of determining a type of the input message based on predefined criteria, and

the identifying step includes the step of using the input message type to identify the data types.

17. The method of claim 15 wherein

the receiving step includes the step of receiving protocol information with the data, and

the assembling step includes the step of removing protocol information from the data.

18. The method of claim 15 wherein the identifying step includes the step of downloading predefined functions for determining the type of the data.

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19. The method of claim 15 wherein the receiving step includes the step of receiving the variable field message formatted according to Edifact protocol.

20. The method of claim 15 wherein the receiving step includes the step of receiving the variable field message from a computerized reservation system.

21. The method of claim 15 wherein the assembling step includes the step of generating a serialized version of the fixed format message.

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22. An apparatus for load balancing of processing provided by multiple server machines interfaced with a client machine servicing multiple customers, comprising:

means for assigning each of the customers to a set of the server machines;

means for storing load levels of each of the server machines; and

means for servicing the customers using the server machines to which they are assigned based upon the load levels, and, if the server machines to which they are assigned are unavailable, for servicing the customers using the server machines to which they are temporarily assigned during the unavailability.

23. The apparatus of claim 22 wherein the servicing means includes

means for receiving a message from the client machine requesting service from server machines to which a particular customer is assigned.

24. The apparatus of claim 23 wherein the servicing means includes

means for receiving a message from the client machine requesting service for the particular customer from any of the server machines.

25. The apparatus of claim 22 wherein the servicing means includes

means for determining if a particular one of the server machines is least loaded among the server machines, and

means for sending a response if the particular server machine is the least loaded server machine.

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26. The apparatus of claim 22 wherein the servicing means includes

means for sending a new load level for a particular one of the server machines to the other server machines.

27. The apparatus of claim 26 wherein the storing means includes

means for updating the load levels with the new load level.

28. The apparatus of claim 22 wherein the servicing means includes:

means for receiving an input message in a variable field format;

means for identifying data types for each field of the input message;

means for assembling an output message having multiple fields defined by a fixed format; and

means for mapping data from the input message to specified fields in the output message based on the identified data types.

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29. A system for load balancing of processing provided by multiple server machines interfaced with a client machine servicing multiple customers, comprising:

a client machine servicing multiple customers;

a plurality of server machines interfaced with the client machine; and

an apparatus servicing the customers by the server machines, the apparatus including:

means for assigning each of the customers to a set of the server machines;

means for storing load levels of each of the server machines; and

means for servicing the customers using the server machines to which they are assigned based upon the load levels, and, if the server machines to which they are assigned are unavailable, for servicing the customers using the server machines to which they are temporarily assigned during the unavailability.

30. The system of claim 29 wherein the servicing means includes

means for receiving a message from the client machine requesting service from server machines to which a particular customer is assigned.

31. The system of claim 30 wherein the servicing means includes

means for receiving a message from the client machine requesting service for the particular customer from any of the server machines.

32. The system of claim 29 wherein the servicing means includes

means for determining if a particular one of the server machines is least loaded

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among the server machines, and

means for sending a response if the particular server machine is the least loaded server machine.

33. The system of claim 29 wherein the servicing means includes

means for sending a new load level for a particular one of the server machines to the other server machines.

34. The system of claim 33 wherein the storing means includes

means for updating the load levels with the new load level.

35. The system of claim 29 wherein the servicing means includes:

means for receiving an input message in a variable field format;

means for identifying data types for each field of the input message;

means for assembling an output message having multiple fields defined by a fixed format; and

means for mapping data from the input message to specified fields in the output message based on the identified data types.

BNSDOCID: <WO___9944155A2_I_>

36. A method for load balancing of processing provided by multiple server machines interfaced with a client machine servicing multiple customers, comprising the steps of:

assigning each of the customers to a set of the server machines;

storing load levels of each of the server machines; and

servicing the customers using the server machines to which they are assigned based upon the load levels, and, if the server machines to which they are assigned are unavailable, servicing the customers using the server machines to which they are temporarily assigned during the unavailability.

37. The method of claim 36 wherein the servicing step includes the step of

receiving a message from the client machine requesting service from server machines to which a particular customer is assigned.

38. The method of claim 37 wherein the servicing step includes the step of

receiving a message from the client machine requesting service for the particular customer from any of the server machines.

39. The method of claim 36 wherein the servicing step includes the steps of

determining if a particular one of the server machines is least loaded among the server machines, and

sending a response if the particular server machine is the least loaded server machine.

BNSDOCID: <WO___9944155A2_I_>

40. The method of claim 36 wherein the servicing step includes the step of sending a new load level for a particular one of the server machines to the other server machines.

41. The method of claim 40 wherein the storing step includes the step of updating the load levels with the new load level.

42. The method of claim 36 wherein the servicing step includes the steps of:

receiving an input message in a variable field format;

identifying data types for each field of the input message;

assembling an output message having multiple fields defined by a fixed format; and

mapping data from the input message to specified fields in the output message based on the identified data types.

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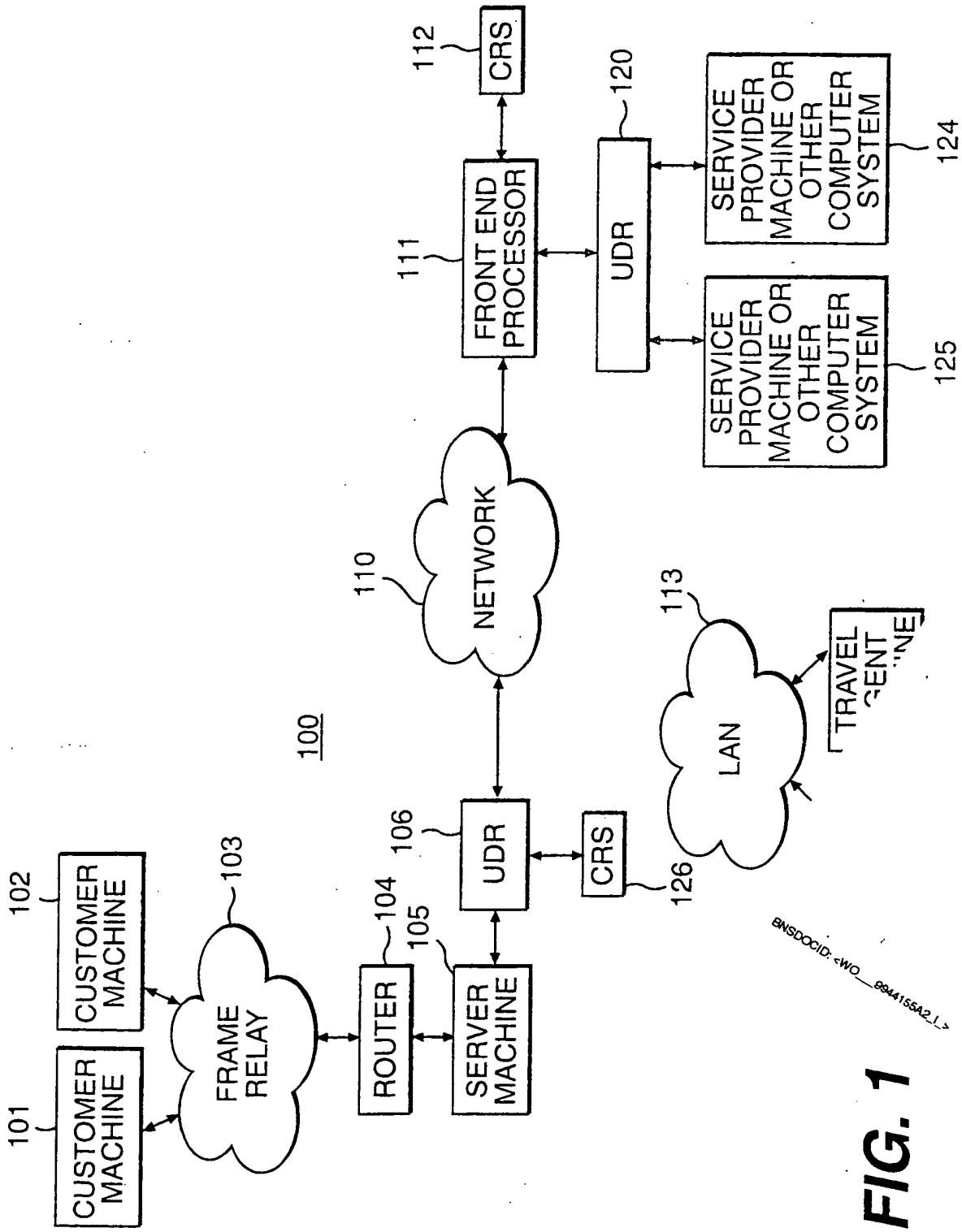

FIG. 1

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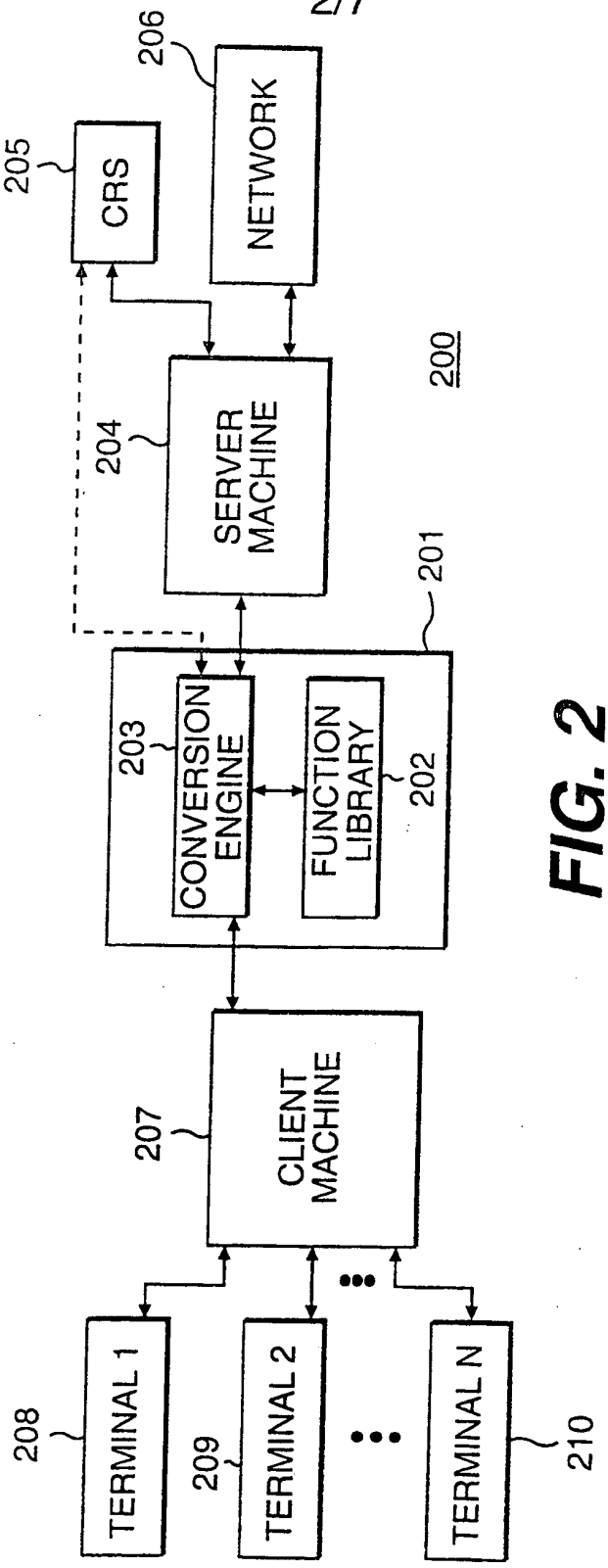

FIG. 2

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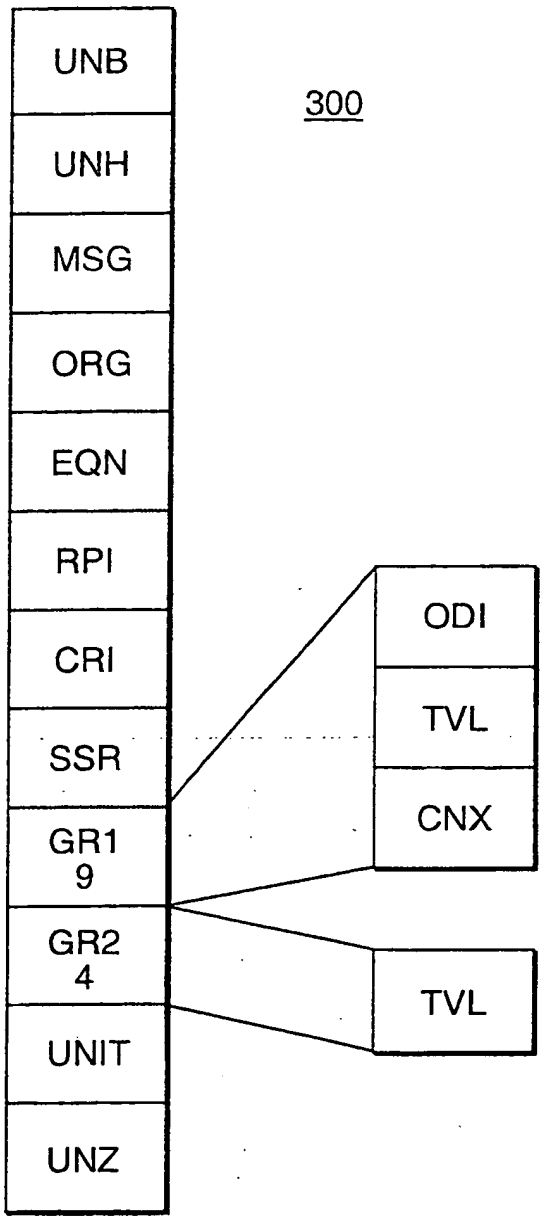

FIG. 3

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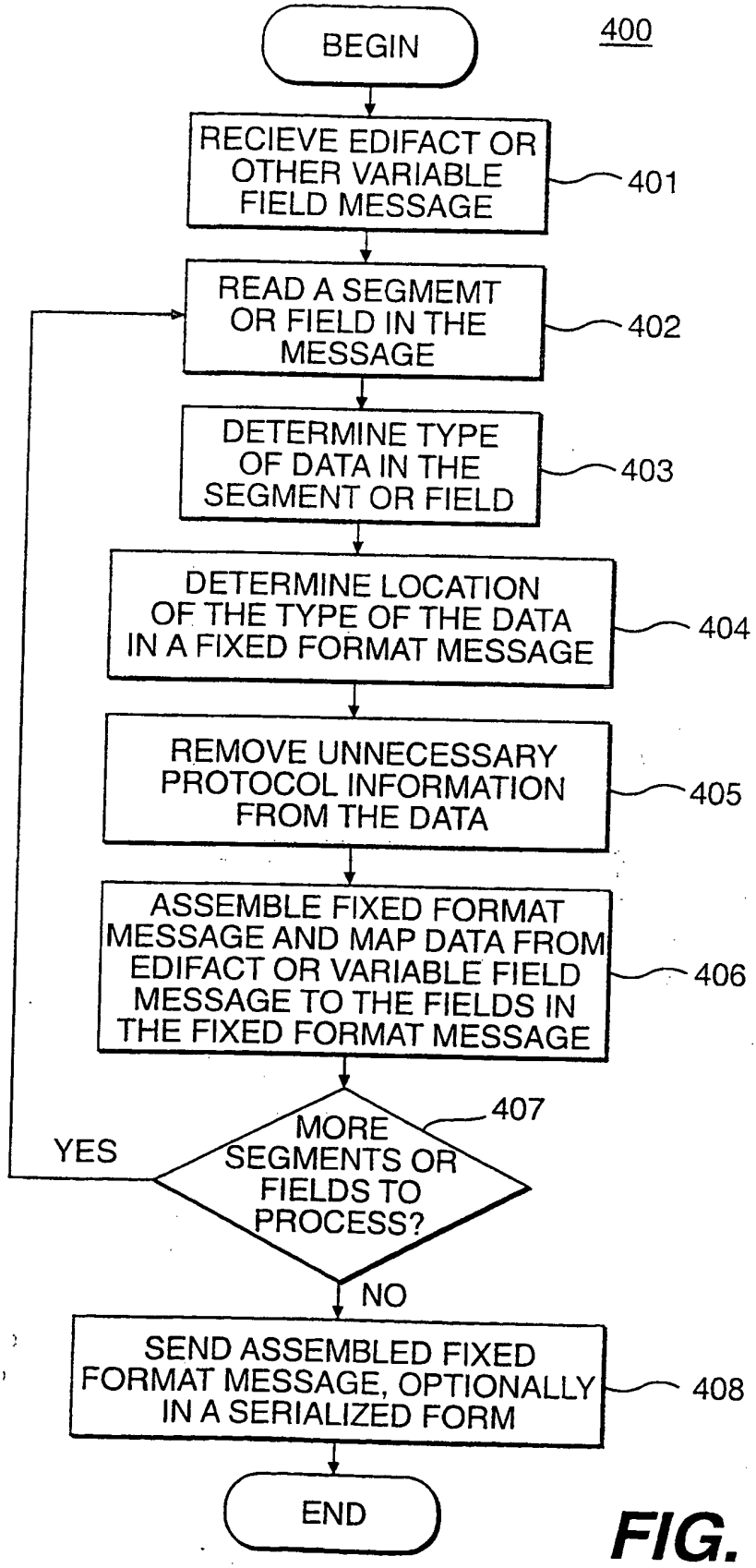

FIG. 4

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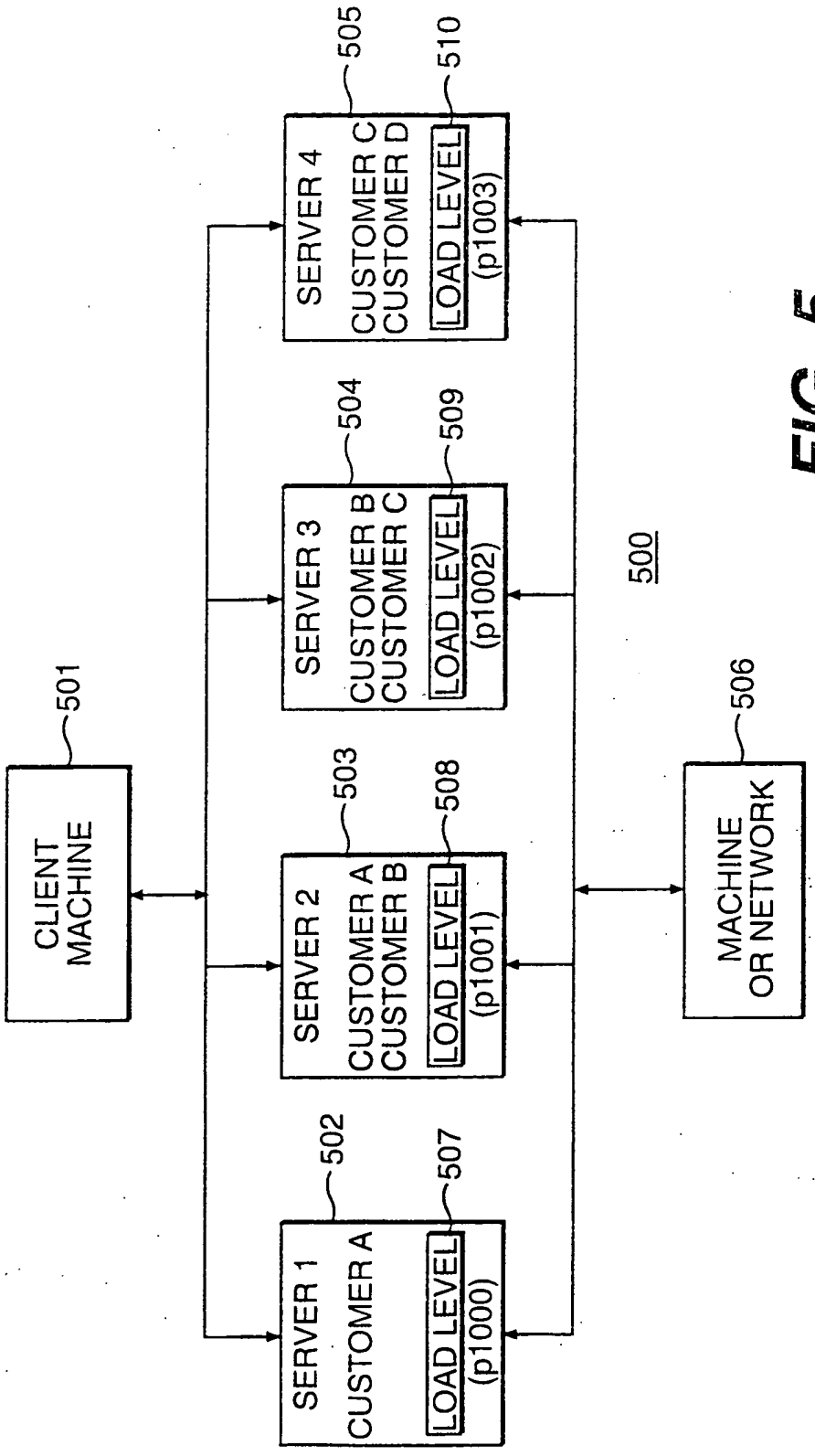

FIG. 5

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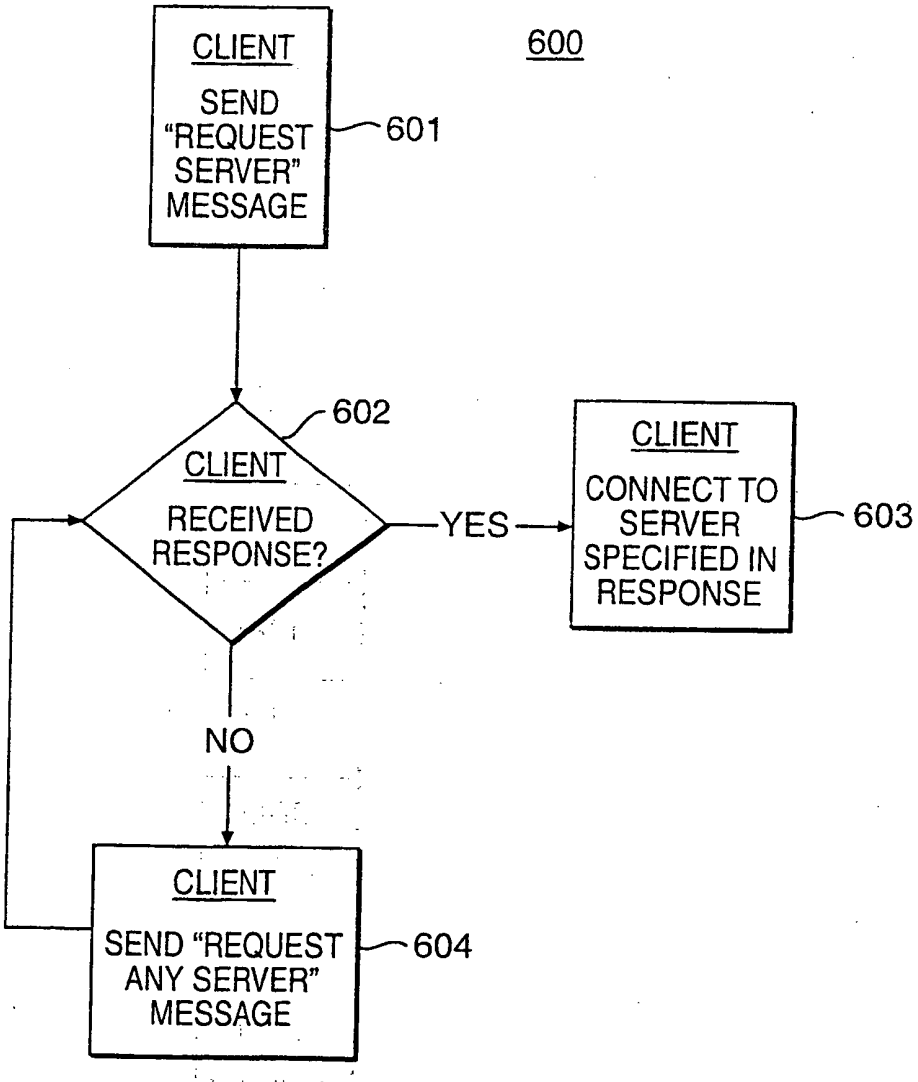

FIG. 6

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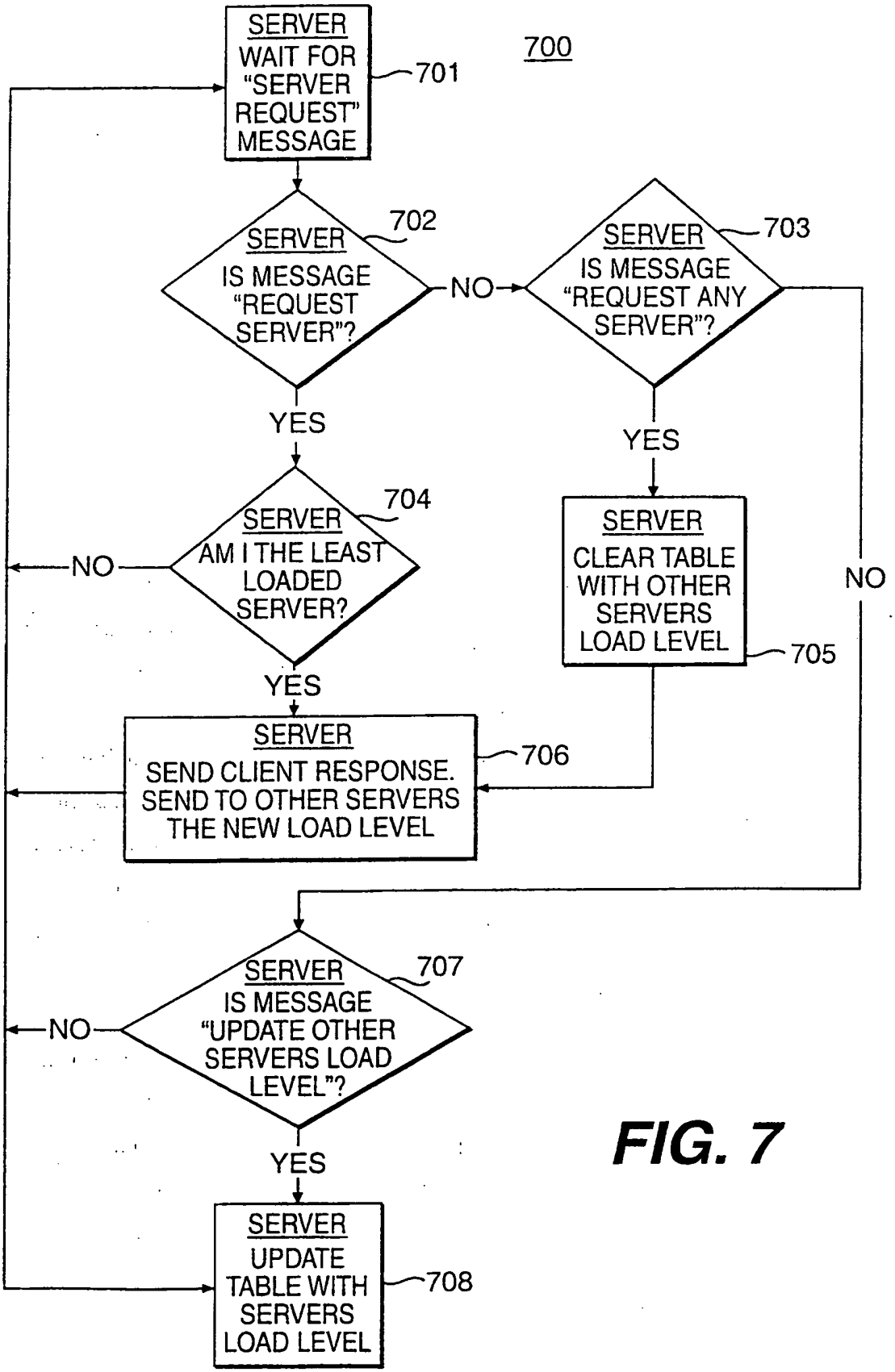

FIG. 7

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(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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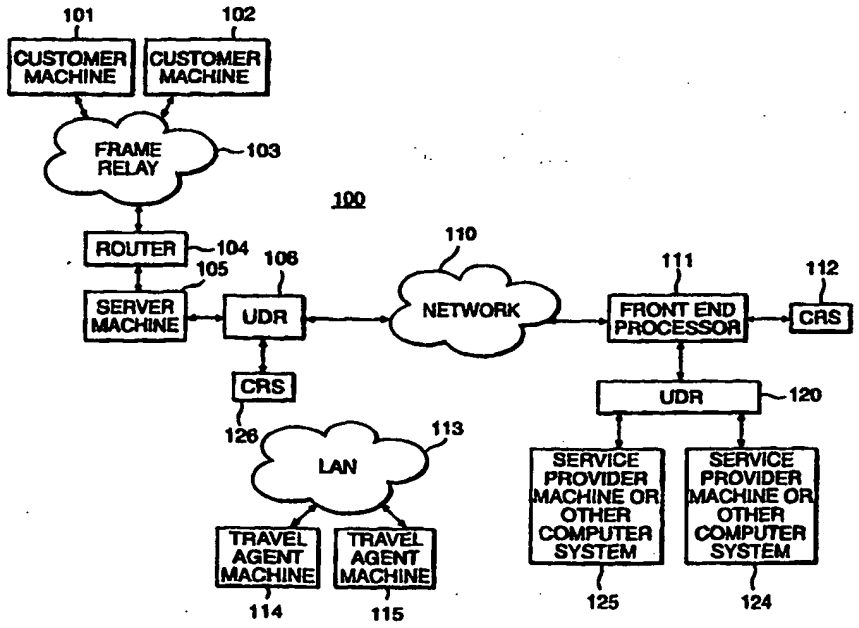
9 March 2000 (09.03.00)

(54) Title: APPARATUS AND METHOD FOR DATA CONVERSION AND LOAD BALANCING IN A COMPUTER NETWORK



(57) Abstract

Conversion of a data in a variable field message to a fixed format message. The variable field message has a varying length and fields of varying types of data. The corresponding fixed format message has fields of a fixed data type and length, which facilitates parsing and processing data from the variable field message. Customers for the data conversion or other processing are load balanced among multiple servers sharing load level information.

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INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/US 99/04070

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G06F9/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	"METHOD FOR UNIVERSAL MAC FRAME ENCODING" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 35, no. 2, 1 July 1992 (1992-07-01), pages 489-493, XP000313371 ISSN: 0018-8689 the whole document	1-3, 6-10, 13-17, 20,21
X	US 5 590 281 A (STEVENS BRUCE W) 31 December 1996 (1996-12-31) column 3, line 7 - line 48	1-3, 6-10, 13-17, 20,21

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15 December 1999	17. 01. 00

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Brandt, J

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BNSDOCID: <WO___9944155A3_I_>

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 99/04070

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	SUDO T: "INFRASTRUCTURE FOR DISTRIBUTED OBJECTS" HITACHI REVIEW, vol. 45, no. 3, 1 June 1996 (1996-06-01), pages 155-160, XP000679571 ISSN: 0018-277X the whole document	1-21
X	WO 97 29424 A (CITRIX SYSTEMS INC) 14 August 1997 (1997-08-14) page 2, line 20 -page 3, line 11	22-42
A	EP 0 240 145 A (TOKYO SHIBAURA ELECTRIC CO) 7 October 1987 (1987-10-07) column 1, line 1 -column 2, line 32	22-42

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inte onal application No.
PCT/US 99/04070

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-21

   Converting between message formats. Stripping of protocols.

2. Claims: 22-42

   Load balancing in a network of servers.

BNSDOCID: <WO___9944155A3_I_>

INTERNATIONAL SEARCH REPORT

Inter ɔnal Application No
PCT/US 99/04070

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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WO 9729424 A	14-08-1997	US 5862348 A	19-01-1999
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		JP 7078785 B	23-08-1995
		JP 62229358 A	08-10-1987
		US 4954945 A	04-09-1990

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